

Project Summary Report 8174

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Rockfall Hazard and Mitigation System

<http://www.mdt.mt.gov/research/projects/geotech/rockfall.shtml>

Introduction

The Montana Department of Transportation (MDT) sought to develop and implement a comprehensive rockfall management system for use on the Department's state-maintained roadways. The goal of this research project was to define the extent of

rockfall conditions and gather data to allow MDT to strategically plan a statewide rockfall mitigation program. The objectives of the program were to 1) reduce the overall rockfall hazard to the motoring public, 2) manage the cost of rockfall maintenance, and 3) limit MDT's exposure to potential

rockfall litigation. The system selected for implementation, and then customized and made suitable for Montana conditions and MDT protocols was the Rockfall Hazard Rating System (RHRS). The RHRS is a nationally recognized rock slope management tool used by many states. Landslide Technology



of Portland, Oregon with Montana-based team members NTL Engineering & Geoscience and Armstrong and Associates completed implementation in July 2005.

What we did

The RHRS system was implemented in a phased manner to promote a more efficient and economical use of resources. The phases include a Preliminary Rating in conjunction with a rock slope inventory, a Detailed Rating of the more hazardous sites, and developing Conceptual Designs and Cost Estimates for the most serious locations. A full discussion of the RHRS can be found in the Research Report or through the Federal Highway Administration (FHWA) RHRS manual, available online through the FHWA Online Publications website at <http://isddc.dot.gov/OLPFiles/FHWA/009767.pdf>.

As an initial step to the Preliminary Ratings, MDT's roughly 10,800 center-line miles of roads were screened for potential rockfall sites using the Department's ImageViewer program. The program displays an image of the roadway every ten meters. This effort identified many potential rockfall sites and it eliminated the need to travel to many of Montana's non-mountainous roadways. A list of the rockfall sites located in each maintenance section was prepared, and using a web-based maintenance interview questionnaire, important

rockfall history and behavior information was gathered for each site.

Following the initial screening and maintenance input, the Preliminary Rating phase was performed during the late summer of 2003. Each site was visited, rated based on its rockfall potential and the site's rockfall history, and assigned a preliminary rating of either "A", "B", or "C." Sites assigned an "A" or "B" rating were entered into the rockfall database along with location information and site photographs. Due to the minimal hazard posed, sites receiving a "C" rating were not entered into the database.

The Detailed Ratings were completed during the summer of 2004 on the A-rated sites. The sites were assessed using a 12-category rating system. Each category represents a certain element that contributes to the overall rockfall hazard, such as slope height, ditch effectiveness, and geologic character. The categories are scored using an exponential scoring system and then added together to determine an overall rockfall site score.

The top 100 A-rated sites had preliminary designs and cost estimates prepared to allow cost considerations to be used as part of strategic planning and project development. The design concepts include only the design elements directly associated with rockfall mitigation so that sites can be compared to each other strictly from a rockfall mitigation standpoint. This allows

decisions to be made based on the benefits of rockfall hazard reduction per dollar invested.

What we found

The number of sites visited and evaluated during the Preliminary Rating phase was 2,653. Of these, 1,869 received either an "A" or "B" rating and were incorporated into the final MDT RHRS database. The remaining sites fell into the "C" category and were excluded from further consideration. The detailed rating was applied at 869 sites. Many of these sites had their Preliminary Rating reduced from an "A" to a "B" rating during or following the Detailed Rating phase. In some cases, a slope that was initially screened as a potential A-rated site received a lower RHRS score and was reassigned to the "B" category. Eventually, based on a decision by MDT's Research Technical Advisory Committee, sites that scored below 350 points were reassigned to the "B" category. Following this final grouping, the MDT RHRS database contains 368 A-rated sites. The highest RHRS score assigned to an MDT rockfall site was 687 points.

The data generated during the RHRS study is stored in the Transportation Information System (TIS) Oracle Database. This database stores the fully implemented Preliminary and Detailed Rating data, GPS coordinates, and several photographs of each site.

The Conceptual Design and

Cost Estimates for the top 100 rated slopes provides MDT with comprehensive information for developing rockfall mitigation projects based on a rational and consistent approach. This extensive rockfall information is a key product of the RHRS process and it allows an unbiased comparison between many rockfall sites and a variety of ways to identify mitigation projects. The recommended mitigation measures ranged from simple, single mitigation techniques to complex mitigation systems involving several design components. Conceptual mitigation costs ranged from \$23,000 to \$1.7 million.

What the researchers recommend

The phased implementation approach used in Montana allowed the average cost for all evaluated sites to be approximately \$150 each. This proved to be much more efficient and cost effective than could have been achieved using a case-by-case process. The implementation investment is offset by the opportunity to improve public safety and reduce the state's rockfall liability exposure by having a rational approach and reliable information to use in allocating limited safety funds.

The three primary goals of this project were to reduce the rockfall hazards faced by the motoring public, gain better tools for managing rockfall costs, and limit the Department's exposure to rockfall

litigation. By implementing the RHRS, MDT has established the basis for attaining each of these goals:

- Safety improvements for the motoring public will be accomplished by allocating mitigation funds at the most appropriate sites based on the identification of rockfall hazard sites statewide. The extensive rockfall information will allow the state to perform strategic planning aimed at optimizing system wide improvements.

- The RHRS will allow more efficient management of MDT's maintenance and construction funds. By targeting rockfall mitigation projects where the greatest score reduction can be realized per dollar invested or where the location allows grouping of sites or mitigation methods, resulting in lower design and unit costs, MDT will reduce rockfall-related operational costs. For the first time,

the important statewide rockfall history from Maintenance has been gathered and documented. Having this rock slope performance information is the first step in effectively managing the rockfall maintenance program.

- Reduction of liability exposure will be realized by having a recognized rockfall management system in place. Courts have determined that it is unreasonable to expect an agency to have at one time the necessary funds to address all their safety related concerns, including rockfall. However, they have indicated that it is reasonable to expect an agency to have a rational system in place to guide decisions for allocating funds as they become available. Implementation of the RHRS, a federally funded, state-of-the-art hazard rating and planning system, will serve MDT ideally in this regard.



For More Details . . .

The research is documented in Report FHWA/MT-05-011/8174, *Rockfall Hazard Classification and Mitigation System*.

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With the completion of the Rockfall Classification and Mitigation Study, MDT is in the process of implementing the results of the study to plan a statewide rockfall mitigation program. The objective of the program is to optimize the use of available funding to reduce the overall rockfall hazard to the motoring public.

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